

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of)	
)	
Amendment of Parts 1, 2, 15, 90 and 95 of the)	ET Docket No. 15-26
Commission's Rules to Permit Radar Services)	
in the 76-81 GHz Band)	
)	
Amendment of Part 15 of the Commission's)	RM-11666
Rules to Permit the Operation of Vehicular)	
Radar Services in the 77-78 GHz Band)	
)	
Amendment of Sections 15.35 and 15.253 of)	ET Docket No. 11-90
the Commission's Rules Regarding Operation)	RM-11555
of Radar Systems in the 76-77 GHz Band)	
)	
Amendment of Section 15.253 of the)	ET Docket No. 10-28
Commission's Rules to Permit Fixed Use of)	
Radar in the 76-77 GHz Band)	
)	
Amendment of the Commission's Rules to)	WT Docket No. 11-202
Permit Radiolocation Operations in the 78-81)	
GHz Band)	

**Comments of Gary Lauterbach
Amateur Radio Operator AD6FP**

My comments address the set of questions regarding amateur radio use of the 76-81 GHz band that the Commission asks in ET Docket No. 15-26.

I have been an Electrical Engineer for 38 years and a licensed amateur radio operator since the age of 12. I have over 45 patents in computer systems, processors, RF systems, packaging, software and control systems. I have been a key contributor in starting multiple companies, defining, designing and delivering products with sales of billions of dollars in the last 38 years.

I have been an active user of the amateur millimeter-wave bands through 80 GHz for the last 12 years. I am currently an active member of the Stanford Amateur Radio Club, W6YX, associated with Stanford University.

Some of my achievements using the millimeter-wave bands include the first amateur use of the moon as a passive reflector at 47 GHz. I have also set multiple terrestrial distance records using the 10, 24, 47 and 80 GHz amateur bands.

Contribution of Amateur Radio

One of the greatest contributions of amateur radio has been and will continue to be in educating and motivating future engineers. In my own case my early interest and use of amateur radio led me to become an Electrical Engineer. This is not an unusual example; David Packard, one of the founders of Hewlett Packard had a similar experience. David Packard was also a member of the Stanford Amateur Radio club where we presently have many students involved in hands-on learning using amateur radio for satellite, moon-bounce and terrestrial communication using amateur frequencies through 80 GHz. The past and future contributions of these amateurs to the US economy is considerable and should not be dismissed.

Commission questions regarding amateur use of 76-81 GHz

In this section each of the Commissions comments/questions regarding amateur use of 76-81 GHz from Docket 15-26 will be shown in ***bold italics*** with my comments following in plain text.

21. In addition to the above services, the Commission also allows amateur radio use within the 76–81 GHz band. Generally speaking, amateur operators use radio spectrum for private recreation, non-commercial exchange of messages, wireless experimentation, self-training, and emergency communication purposes. The amateur radio community previously stated that the frequencies in the 76–81 GHz range (which it identifies as the “4 mm band”) are well suited for experiments relating to short-range high-speed data communication. The Commission has previously considered compatibility issues for amateur operations with vehicular radar and FOD detection radar operations. In light of concerns about interference between amateur operations and vehicular radars, the Commission imposed (and, more recently, maintained) a suspension of the amateur-satellite service allocation in the 76–77 GHz band.

The previous concerns of the Commission of interference between amateur operations and vehicular radar in the 76-77GHz segment were without any supporting technical analysis or data contained in the record¹. The prior partitioner, GM, in fact expressed no concern of interference from the amateur radio service². Compatibility concerns can of course occur in either direction between two services sharing spectrum with either service being the aggressor or the victim. Suspending a service for being a victim would seem to not be in the interest of that service. The

¹ FCC 95-499

² ET Docket 94-124

only record of compatibility analysis between amateur services and vehicular radar that I was able to find was with the vehicular radar as the aggressor and the amateur service as the victim³.

In fact the 79GHz project⁴ efforts in interference analysis (MOSARIM⁵) have focused on the LRR-SRR and SRR-SRR interference cases because they believe that is the most severe interference that will be encountered. Given the large number of radars per vehicle (6 or more) as well as the large number of possible vehicles within 100m (20 or more) hundreds of SRR mutual aggressors can be expected. Unlike any amateur service aggressor these SRR mutual aggressors will be utilizing the same modulation type, wider beam width antennas and can be spatially very close (less than 10 meters).

34. In its petition, Bosch states that it expects no interference issues between Amateur Radio operation and vehicular radar operations at 77–81 GHz. It notes that it is unconvinced after several meetings with the technical staff of ARRL that there is any “significant incompatibility” and describes how amateur operations in the band “tend to be largely experimental, occurring in geographic areas such as mountaintops and other rural areas where motor vehicle operation is not typical.” However, the Commission has previously recognized evidence of potential interference conflicts between the amateur-satellite service and vehicular radar systems in the 76–77 GHz band. Given that similar propagation characteristics exist throughout the millimeter wave band frequencies, there appears to be the potential for similar compatibility issues to exist between the amateur-satellite service and vehicular radar systems above 77 GHz. The Commission seeks to expand its record on the compatibility between amateur and vehicular radar services. In particular, are there any mitigation strategies for compatibility between the two services? Are there any additional interference or compatibility studies that may exist on the subject? The goal is to adopt rules that address amateur use, including amateur satellite use, within the 76–81 GHz band in a comprehensive and consistent manner.

As previously mentioned, the FCC record contains no evidence or technical analysis of interference between the amateur service and vehicular radar. The 79GHz project has contracted an analysis of interference potential and mitigation strategies by MOSARIM⁶ focused on mutual interference between SRRs.

There are many mitigation strategies given the significantly different usage of the spectrum between the amateur service and vehicular radar:

- Amateurs utilize very high gain antennas with very narrow beam widths greatly reducing the probability of the maximum field strength being aligned with a vehicular radar.

³ ECC report 56, Stockholm 2004, <http://www.erodocdb.dk/docs/doc98/official/pdf/ECCRep056.pdf>

⁴ <http://www.79ghz.eu/index.php/project>

⁵ MOSARIM Project Final Report, 2012-12-21, <http://cordis.europa.eu/docs/projects/cnect/1/248231/080/deliverables/001-D611finalreportfinal.pdf>

⁶ <https://assrv1.haw-aw.de/mosarim/index.php>

- While not currently limited to narrow band modulation, the typical amateur use of the 4mm band is with modulation less than 4KHz wide.
- Amateur stations at this frequency usually operate from high, remote mountain tops with a physical separation from primary and secondary roads of greater than 2Km.

60. In conjunction with our efforts to develop a comprehensive policy for use of the 76–81 GHz band, the Commission seeks comment on how it should structure future amateur 4 mm band use. As background, the Commission decided to temporarily restrict amateur station access to the 76–77 GHz band in 1998 to ensure against potential interference to what were then newly developing vehicular radar systems. The Commission observed that amateur station transmissions in the 76–77 GHz were not significant at the time, reasoned that its action would not have an immediate impact on amateur operators, and stated that it planned to revisit the issue later. In 2004, the Commission extended the amateur-satellite allocation suspension, citing interference issues and suggesting that it would be useful to consider the development of technical sharing criteria for the band. Bosch, in its petition, does not seek to alter the current 76–77 GHz arrangement.

Neither Bosch nor the prior vehicular radar petitioner GM sought to restrict sharing the 4mm band with the amateur service. The FCC concern of interference is without any technical evidence or technical analysis in the record. While in theory the amateur service is permitted extraordinary EIRP levels, in practice the realizable EIRP levels are quite limited. Amateur transmitter power levels in the 4mm band are typically between 1mw and 200mw. While a small number of higher power sources are available it is only at extreme costs (more than \$200,000) and beyond the reach of amateurs. Even at these extreme costs the power levels achievable are 100w or less, the amateur power limit of 1500w is effectively moot.

Antenna gains on the order of 40-60 dbi are typical resulting in EIRP levels of no more than 83 dbm for the most capable amateur station. Higher gain antennas while possible in theory are not practical due to extreme difficulty in pointing from the narrow beam width. Also note that these amateur antennas of 40+ dbi gain have very narrow beam widths making the probability of the full strength field being bore sight aligned with a vehicular radar very unlikely.

61. Based on our proposals for new vehicular and other radars in the 77–81 GHz band, the Commission proposes to adopt a comprehensive approach for amateur radio use on these frequencies. Given the continuing lack of technical sharing criteria or any other evidence of compatibility, should the Commission extend the 76–77 GHz amateur suspension to the entire 76–81 GHz band? If so, should the Commission modify the current amateur suspension of use of the 76–77 GHz band by removing all amateur allocations from the 76–81 GHz band? Alternately, would it be possible to lift our suspension of the amateur service and conduct both amateur and vehicular radar operations in the entire 76–81 GHz

band? The Commission tentatively concludes that there is no apparent technical reason to treat the 76–77 GHz and the 77–81 GHz bands differently. Commenters who believe that the Commission should continue to distinguish between the two bands should explain the reasons for doing so. The Commission also seeks comment on whether there are other approaches that would achieve compatibility between the amateur and radiolocation services within the 76–81 GHz band that the Commission has not discussed above.

I believe the amateur service can readily coexist with vehicular radar in the 4mm band in agreement with the petitioner. The suspension of amateur use of the 76-77GHz segment should be lifted since the available studies referenced above show co-existence to be practical. Removing all amateur allocations is contrary to both the available interference studies as well as the request of the petitioner.

The interference potential of LRR in the 76-77GHz band and the potential of SRR in the 77-81GHz band to the amateur service as a victim has a negligible difference. Therefore I agree with the Commission that the entire band from 76-81GHz should be treated uniformly.

62. Bosch, in its petition, states that it “is unconvinced, after several meetings with technical staff of ARRL, the national association for Amateur Radio, that there is any significant incompatibility between Amateur Radio and SRR operation at 79 GHz.” It says the nature of amateur use of this spectrum—largely experimental and occurring on mountaintops and locations where motor vehicle operation is not typical—will provide sufficient geographic separation to prevent interference from amateur users to new vehicular radar operations above 77 GHz. However, Bosch also notes that European regulators previously determined “that the use of SRR within the band 77–81 may be incompatible with the Radio Amateur Service,” but also concluded that amateur users could be accommodated in the 75.5–76 GHz band (which is not currently available in the U.S.). The Commission seeks comment on these points. Additionally, to help better inform its decision, the Commission seeks to develop a record on the types of amateur use, and the extent of such use, that is currently undertaken in the amateur 4 mm band.

The use of the 77-81 GHz band in the San Francisco South Bay area includes the following stations that are all regularly active (Table 1). The usage patterns include local testing over paths of 10-40Km length as well as remote mountain top usage with path lengths of 50-300Km. In both these cases physical separation from primary and secondary roads by distances of 2Km or more is easily achievable.

The possible incompatibility that the European regulators refer to is with the amateur service as a victim due to the noise generated by vehicular radar as the aggressor. This possible incompatibility is likely for amateur space communication where low background noise is vital due to the very low signal to noise ratios.

Call Sign	Name	Estimated EIRP dbm
AD6FP	Gary Lauterbach	55

Call Sign	Name	Estimated EIRP dbm
KF6KVG	Bob Johnson	66
KF6KVG/B	Beacon, Mt. Leeson	45
K6GZA	Ron Smith	71
AA6IW	Lars Karlsson	55
AD6IW	Goran Popovic	68
N9JIM	Jim Moss	52
W0EOM	Will Jensby	54

Table 1

63. To the extent that commenters believe that amateur operators can continue to use the millimeter band, the Commission seeks comment on what additional rule modifications it would have to adopt to realize successful shared use of the entire band. For example, our existing service rules would permit amateur operators to transmit with significantly higher power than other proposed operations. Would adopting the same emission limits for amateur operations as the Commission proposed for other services in this band reduce the potential for mutual interference? Are there any additional conforming edits to the part 97 amateur radio service rules that the Commission would have to implement?

As discussed above the amateur power limit is a moot point at these frequencies. The comments of the Commission indicate that the interference concern is with the amateur service as an aggressor despite the lack of any technical analysis to support this concern. While I don't think it is necessary, a more reasonable approach would be a sliding emission limit based on the separation of the amateur station from any primary or secondary road as well as a limitation to narrow band width modulation. Since both the LRR and SRR emission limits are 55 dbm EIRP and mutual interference will occur at distances well below 100m that can conservatively be used as a baseline for amateur emission limits. Free space path loss increase of 20db per decade of distance increase can then provide additional EIRP increases for amateur stations that are operated at a distance from roadways, see table 2 for an example. Note that this doesn't include mitigation due to narrow bandwidth modulation, narrow beam width antennas, low density of amateur stations, cross polarization of antennas and so is an extremely conservative estimate of safe amateur emission limits.

Separation Distance Km	Amateur EIRP dbm
< 0.1 Km	55
>= 1 Km	75
>= 10 Km	95

Table 2.

64. If, instead, the Commission were to remove all amateur allocations from the 76–81 GHz range, it seeks comment on alternate spectrum that it might be able to make available in this general region. Bosch recommends an amateur allocation at 75.5–76 GHz, arguing that such an allocation would permit re- accommodation of any displaced Amateur Radio operators as the result of aggregate noise from SRRs in the 79 GHz band, and harmonize the United States Amateur allocation with that in ITU Region 1 and in other areas of the world. The Commission seeks comment on allocating the 75.5–76 GHz band to the amateur service if the Commission were to remove the amateur allocation, including amateur satellite, in the 76–81 GHz band.

Aligning the amateur service US allocation with that of ITU Region 1 for the 75.5-76GHz band is logically consistent with the alignment of the 76-81 GHz band for vehicular radar. If this was made a primary allocation it would provide a low noise segment that would be suitable for satellite and moon bounce use by the amateur service. I note that the Bosch recommendation of this re-alignment is to protect the amateur service as a victim from the vehicle radar service as an aggressor. The above analysis however indicates that it should be unnecessary to remove all amateur allocation from the 76-81GHz range as long as the amateur service can tolerate the interference from the vehicular radar service. Given the analysis in the ECC-56 report⁷ this toleration is likely acceptable for all but amateur space communication use. To reiterate, in all of the analysis of compatibility between the amateur radio service and vehicular radar, they have been done with vehicular radar as the aggressor and the amateur service as the victim.

Summary

- Neither partitioner⁸ for vehicular radar use of 76-81GHZ has been concerned about a compatibility issue between the amateur service and the vehicular radar service.
- Prior published analysis has been performed with the amateur service as the victim and the vehicular radar service as the aggressor. The result being that for all but low noise space

⁷ ECC report 56, Stockholm 2004, <http://www.erodocdb.dk/docs/doc98/official/pdf/ECCRep056.pdf>

⁸ ET Docket 94-124, ET Docket 15-26

communication, the amateur service as a victim can tolerate the noise level expected from the vehicular radar service.

- Reasonable EIRP limits combined with physical separation and narrow bandwidth modulation will preclude any concern of the amateur service being an aggressor toward the vehicular radar service in the 76-81GHz segment.
- Allocating the 75.5-76GHz to amateur satellite service as a primary user will provide a low noise segment for space communication use as well as align the US spectrum use with ITU region 1. This segment should be free from any EIRP limits for sharing the 76-81 GHz segment.

Respectfully Submitted,

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